

### ABSTRACT OF THE DISCLOSURE

A circuit includes a single circuit portion for implementing the Advanced Encryption Standard (AES) block cipher algorithm in a system having a plurality of channels. The circuit portion includes a circuit for individually generating, on the fly, the round keys used during each round of the AES block cipher algorithm. The circuit portion also includes shared logic circuits that implement the transformations used to encrypt and decrypt data blocks according to the AES block cipher. The single circuit portion encrypts or decrypts data blocks from each of the plurality of system channels in turn, in round-robin fashion. The circuit portion also includes a circuit for determining S-box values for the AES block cipher algorithm. The circuit additionally implements an efficient method for generating round keys on the fly for the AES block cipher decryption process.